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A RECORD OF *RHINOLOPHUS ARCUATUS* (CHIROPTERA: RHINOLOPHIDAE) FROM NEW GUINEA, WITH THE DESCRIPTION OF A NEW SUBSPECIES

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ABSTRACT

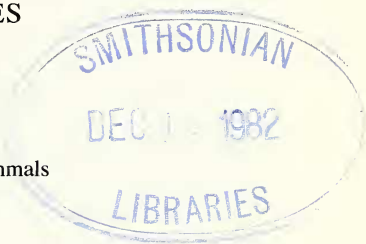
The Indo-Australian species of *Rhinolophus* currently referred to the *R. arcuatus* group are keyed and listed, with the description of a new subspecies of *R. arcuatus* from New Guinea, whence the species has not hitherto been recorded. Three species of the genus, *R. megaphyllus*, *R. euryotis*, and *R. arcuatus* are now known from New Guinea or the nearby islands, and comparative notes are provided.

INTRODUCTION

Among the numerous species of Indo-Australian bats of the genus *Rhinolophus* only *R. megaphyllus* and *R. euryotis* have been reported from New Guinea or from the islands immediately nearby, although on distributional grounds it is possible that the widespread species *R. philippinensis* may also occur there. Two species, *R. megaphyllus* and *R. philippinensis*, are known to occur in Australia but the genus is unknown from the Solomon Islands, the New Hebrides, or from any of the Pacific islands further to the east. It seems clear that Australia,

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with New Guinea and some of its more closely associated islands such as those of the Bismarck Archipelago (Koopman, 1979) to the north-east or the Louisiade Archipelago immediately to the east, may mark the eastward extension of this widely distributed Old World genus, especially when their apparently rather sparse rhinolophid fauna is compared with the profusion of species that occur in the Malaysian region to the west. The discovery of a third species, *R. arcuatus*, in New Guinea therefore has both faunal and zoogeographic interest, perhaps the more so because its representative in New Guinea seems more closely allied to those from the Philippine Islands, Borneo, and Sumatra than to those from the geographically nearer Molucca Islands.

Two of the six groups of *Rhinolophus* recognized by Andersen (1905b, 1918) and, in the Orient, of the four delimited by Tate and Archbold (1939) thus occur in New Guinea, with *R. megaphyllus* representing the *ferrumequinum* (= *simplex* or *megaphyllus*) group, and *R. euryotis* and *R. arcuatus* the *arcuatus* (= *euryotis*) group. Numerous representatives of both groups occur elsewhere to the west, the *ferrumequinum* complex extending to the Palaearctic and Ethiopian regions, the *arcuatus* group to the Philippine Islands and to the southeast Asian mainland. The *philippinensis* (= *luctus*) group (including the *macrotis* group of Andersen, 1905b) has a predominantly Oriental and African distribution. It is represented in the eastern part of the Indo-Australian region by *R. philippinensis* in Sulawesi, Timor (Goodwin, 1979), and in Queensland, Australia, a pattern suggesting that in time it may be found in New Guinea. No member of the *pusillus* (= *minor* or *lepidus*) group has been reported east of Borneo and the more westerly (Lombok) of the Lesser Sunda Islands, although like the *ferrumequinum* group it extends to the Palaearctic and Ethiopian regions. The *midas* group of Andersen (1905b) is primarily Palaearctic but just extends into Africa; the *macrotis* group as defined by the senior author is found in both Africa and the Orient but in the east does not extend beyond the Philippine Islands, Malaya, and Sumatra. Tate (1943) incorporated this last group into the *philippinensis* complex, with which its members closely agree.

SYSTEMATICS

Members of the *arcuatus* group of *Rhinolophus* are characterized by large, broad ears with well developed rectangular antitragal lobe; a large, wide noseleaf that covers the muzzle; an expanded internarial septum; a large, usually ovate or sub-ovate sella; the skull with high, projecting median anterior rostral swellings and short palatal bridge; its length one-third to one-quarter the length of the maxillary toothrow; dentally, the small anterior upper premolar (PM2) remains in the toothrow; the second lower premolar (pm3) being very small and extruded.

They differ from the members of the *philippinensis* group chiefly in the presence of a high connecting process and in the very short palatal bridge; however, *R. macrotis* of the *philippinensis* group has a higher process than most of the associated species but has a very long palate, and in the *arcuatus* group, *R. creaghi* and *R. canuti* lack any real connecting process, which in these is replaced by a tuft of hairs. The *arcuatus* group also overlaps in the Moluccas and New Guinea with members of the *ferrumequinum* group, but in these the ears and antitragus are not greatly enlarged, the internarial septum little expanded, and the facial part of the skull is long with the median rostral swellings not especially high and projecting. All have a rounded connecting process but it originates on the back of the sella from a point below the tip, rather than from the apex of the sella as is more usual in the *arcuatus* group.

The *Rhinolophus arcuatus* group was briefly reviewed and characterized by Andersen (1905a) and its species and subspecies listed by Tate and Archbold (1939). The several species currently referred to it may be keyed:

1. Anterior leaf narrowly emarginated, the emargination prolonged posteriorly as a narrow, linear groove on face of leaf, extending less than halfway to internarial region 2
 Anterior leaf scarcely emarginated, but with broad, parallel swollen longitudinal ridges extending from edge of leaf to internarial region, enclosing a groove that widens posteriorly to terminate at a low, median projection *euryotis*
2. Connecting process low or obsolete; lower part of posterior leaf densely pilose 3
 Connecting process evident; lower part of posterior leaf, at most, sparsely haired 4
3. Upper part of sella thickened posteriorly; connecting process obsolete; hairs at base of posterior leaf forming a dense, bristly sub-conical tuft *creaghi*
 Upper part of sella lacking any posterior thickening; connecting process low, rounded; hairs at base of posterior leaf long, dispersed *canuti*
4. Posterior leaf thickened and folded to form a vertical fissure enclosing rear of connecting process 5
 Rear of connecting process attached directly to face of posterior leaf, not enclosed 6
5. Postnarial rostral depression prominent, moderately deep, elongate, enclosed by broad, well developed supraorbital ridges *coelophyllus*
 Postnarial rostral depression shallow, short, little developed; supraorbital ridges narrow *shameli*
6. Upper part of sella unmodified 7
 Upper part of sella forming a small, triangular pouch, its opening directed downwards *inops*
7. Size small to moderate, length of forearm not exceeding 60 mm 8
 Large, length of forearm 66–71 mm *rufus*
8. Larger, length of forearm 53–57 mm, maxillary toothrow 9.5–10.4 mm; internarial cup narrow; prominent frontal depression *subrufus*
 Smaller, length of forearm 42–51 mm, maxillary toothrow 7.8–8.6 mm; internarial cup expanded; shallow frontal depression *arcuatus*

Subspecies, where appropriate, and distributions are:

- Rhinolophus euryotis euryotis* Temminck, 1834
Ambon I, Ceram I, Timor Laut I, Molucca Is; Sulawesi (The Sulawesi population is currently under description by the senior author as a distinct subspecies.)
- Rhinolophus euryotis timidus* Andersen, 1905a
Batchian I, North Molucca Is; New Guinea; Bismarck Is (Smith and Hood, 1981)
- Rhinolophus euryotis praestans* Andersen, 1905a
Kei Is
- Rhinolophus euryotis aruensis* Andersen, 1907a
Aru Is
- Rhinolophus euryotis burius* Hinton, 1925
Buru I, Molucca Is
- Rhinolophus creaghi creaghi* Thomas, 1896
Borneo
- Rhinolophus creaghi pilosus* Andersen, 1918
Madura I
- Rhinolophus canuti canuti* Thomas and Wroughton, 1909
Java
Formerly thought conspecific with *creaghi* by Hill (1958)
- Rhinolophus canuti timorensis* Goodwin, 1979
Timor I
- Rhinolophus coelophyllus* Peters, 1867
Burma—N Malaya; Langkawi I
Placed in *arcuatus* group by Andersen (1905b) and by Tate and Archbold (1939) but removed, with *shameli*, to *philippinensis* group by Tate (1943); however, it has a very short palate.
- Rhinolophus shameli* Tate, 1943
Burma—Campuchea
- Rhinolophus inops* Andersen, 1905a
Mindanao I, Philippine Is
- Rhinolophus rufus* Eydoux and Gervais, 1836
Luzon I, Mindanao I, Philippine Is
- Rhinolophus subrufus subrufus* Andersen, 1905a
Luzon I, Mindoro I, Negros I, Philippine Is

- Rhinolophus subrufus bunkerii* Taylor, 1934
Mindanao I, Philippine Is
- Rhinolophus arcuatus arcuatus* Peters, 1871
Luzon I, Philippine Is
- Rhinolophus arcuatus exiguus* Andersen, 1905a
Mindanao I, Philippine Is
- Rhinolophus arcuatus beccarii* Andersen, 1907b
Sumatra
- Rhinolophus arcuatus toxopeusi* Hinton, 1925
Buru I, Molucca Is
- Rhinolophus arcuatus angustifolius* Sanborn, 1939
Wetter I, Southwest Is, Flores Sea
- Rhinolophus arcuatus proconsulis* Hill, 1959
Sarawak, Borneo
- Rhinolophus arcuatus mcintyreii*, subsp. nov.
New Guinea

Rhinolophus arcuatus mcintyreii, subsp. nov.

Holotype.—CM 63497. Adult ♀. 4 km ENE Telefomin, W Sepik Province, Papua New Guinea (05°06'S, 141°41'E). Obtained in limestone cave by hunter on 6 March 1980 and prepared by Duane A. Schlitter, field number 4598 and BBM-NG field series number 105904. Skin and skull.

Additional specimens (10).—PAPUA NEW GUINEA: W Sepik Province, 4 km ENE Telefomin, 10 (3 BBM-NG, 1 BMNH, 2 CM, 4 PNGM).

Diagnosis.—A large subspecies of *R. arcuatus*, similar in size to *R. a. proconsulis* but differing from this and from the other subspecies in more expanded internarial region; shorter, wider sella and larger, more inflated median anterior rostral swellings; differing further from *R. a. proconsulis* in smaller, less massive canine teeth; from *R. a. beccarii* in higher, less flattened anterior rostral swellings and from *R. a. angustifolius* and *R. a. toxopeusi* in relatively shorter tail; cranially a little larger than all except *R. a. arcuatus* and *R. a. proconsulis*.

Description.—Ears large, broad, anterior or medial margin slightly convex to pointed tip, posterior margin concavely emarginated just beneath tip, thereafter convex; well-developed rectangular antitragus; posterior part of pinna above antitragus with a series of transverse involutions; interior surface of pinna pilose at base of medial margin, lower third of outer or medial surface and external face of antitragus similarly haired; noseleaf large, almost covering muzzle, the anterior leaf supported anterolaterally by a well developed fleshy ridge; anterior leaf with slight median emargination prolonged poste-

riorly as a faint groove extending about halfway across the flange of the leaf (in contrast to *R. euryotis* in which broad ridges enclose laterally a median groove across the leaf, terminating posteriorly in a low median projection); surface of anterior leaf with a sparse cover of short, grayish hairs; each nostril with prominent, sub-tubular lappets; internarial region expanded into an angular, slightly cup-like structure, about one-third as wide as anterior leaf, not totally concealing nostrils; sella short, wide, at its base and for much of its length only slightly narrower than the internarial cup, tapering slightly in its upper part to rounded tip, its face with a moderate cover of short, grayish brown hairs; connecting process high, rounded, originating anteriorly at tip of sella; lancet densely pilose, with slightly concave margins rising to rounded tip, its upper part narrowed, almost spatulate; length of second phalanx of third digit more than one and one-half times the length of the first phalanx; fifth metacarpal very slightly longer than fourth (in contrast to *R. megaphyllus* in which the length of the second phalanx of the third digit is less than one and one-half times the length of the first phalanx and in which the fifth metacarpal is shorter than the fourth or equal to it in length); dorsal pelage mid-brown, the hairs creamy white at the base and for much of their length, with pale brown or brown tips; ventral surface paler, with much of the pale base color exposed.

Skull relatively large, with elongate, slightly inflated braincase and low sagittal crest; interorbital region abruptly narrowed; rostrum high, with slightly developed supraorbital crests, their junction enclosing a very shallow frontal depression; anterior rostral swellings large, wide, the median pair strongly inflated, high and projecting; palate short, its anterior edge on a line joining the centers of the posterior upper premolars (PM4-4), its posterior edge just in advance of a line joining the centers of the second molars (M2-2); basioccipital not especially narrowed; anterior upper premolar (PM2) small, in tooththrow, second lower premolar (pm3) very small, almost totally extruded.

Measurements.—See Tables 1 and 2.

Etymology.—This new subspecies is named after Thomas J. McIntyre in appreciation of his keen interest in Australasian mammals and enormous support and assistance in the junior author's research on Old World mammals.

Remarks.—In size *R. a. mcintyreii* tends towards the Philippine subspecies *R. a. arcuatus* and the Bornean *R. a. proconsulis*, differing in this respect from the geographically much nearer *R. a. angustifolius* from Wetter Island and *R. a. toxopeusi* from Buru in the Moluccas, or from *R. a. exiguus* from Mindanao in the Philippine Islands and *R. a. beccarii* from Sumatra. At present, however, all seem poorly represented in collections, and no proper assessment of geographic variation can be made.

Little mensural data are available for *Rhinolophus arcuatus*. Some mensural data were analyzed by using ANOVA of the UNIVAR program. The statistics generated are mean, range, standard deviation, standard error of the mean, variance, and coefficient of variation. The program employs a single classification analyses of variance (F-test, significance level 0.05) to test for significant differences between or among means. Standard statistics and a comparison between samples of males and females from the type locality of *R. a. mcintyreii* are given in Tables 1 and 2. Although samples are small, results of the comparison indicate that males may be significantly larger than females for

Table 1.—Statistical comparison of selected external measurements of six adult male and five adult female *Rhinolophus arcuatus meintyreii* from the type locality. Statistics given for each sex are mean, standard error, range, and coefficient of variation. Measurements for holotype (CM 63497) are listed in right column of table.

Measurements	Males			Females			CV	Holotype
	Mean \pm 2 SE	(Range)	CV	Mean \pm 2 SE	(Range)	CV		
	Total length	80.8 \pm 1.74	(78–83)	2.64	81.0 \pm 2.10	(77–83)		
Tail length	18.5 \pm 0.68	(18–20)	4.52	17.8 \pm 1.17	(16–19)	7.32	21	
Ear length	20.8 \pm 0.61	(20–22)	3.61	20.8 \pm 0.40	(20–21)	2.15	21	
Weight	13.5 \pm 0.68	(13–15)	6.20	13.8 \pm 1.17	(12–15)	9.45	15	
Length of tibia	23.0 \pm 0.53	(22.0–23.7)	2.80	23.1 \pm 0.69	(22.0–23.9)	3.33	23.9	
Length of forearm	51.3 \pm 1.10	(49.8–53.4)	2.64	49.9 \pm 1.17	(48.6–51.7)	2.61	50.5	
Length of third metacarpal	38.5 \pm 0.61	(37.6–39.5)	1.95	38.2 \pm 0.90	(36.6–39.1)	2.64	39.1	
Length of third, first phalanx	14.5 \pm 0.45	(13.6–15.1)	3.83	14.3 \pm 0.35	(13.8–14.7)	2.73	14.7	
Length of third, second phalanx	23.6 \pm 1.09	(21.7–25.7)	5.64	24.3 \pm 1.24	(22.9–26.4)	5.72	26.4	
Length of fourth metacarpal	39.5 \pm 0.95	(38.0–41.5)	2.95	39.2 \pm 1.03	(38.1–41.0)	2.94	41.0	
Length of fourth, first phalanx	9.8 \pm 0.42	(9.2–10.6)	5.21	9.6 \pm 0.35	(9.0–10.1)	4.14	9.7	
Length of fourth, second phalanx	14.2 \pm 0.47	(13.5–15.0)	4.01	14.1 \pm 0.42	(13.5–14.7)	3.35	13.9	
Length of fifth metacarpal	40.0 \pm 1.15	(37.7–41.4)	3.52	39.8 \pm 1.06	(38.6–41.7)	2.97	41.7	
Length of fifth, first phalanx	11.2 \pm 0.28	(10.8–11.6)	3.04	11.1 \pm 0.38	(10.5–11.5)	3.87	11.3	
Length of fifth, second phalanx	13.0 \pm 0.60	(12.2–14.1)	5.66	13.0 \pm 0.50	(12.2–13.7)	4.32	13.7	
Width of anterior leaf	9.2 \pm 0.27	(8.7–9.7)	3.60	9.0 \pm 0.23	(8.7–9.4)	2.83	9.0	
Width of internarial cup	3.3 \pm 0.07	(3.2–3.4)	2.50	3.3 \pm 0.12	(3.2–3.5)	4.02	3.5	
Width of sella at base	2.4 \pm 0.04	(2.4–2.5)	2.12	2.6 \pm 0.16	(2.4–2.8)	7.10	2.7	
Height of sella	2.9 \pm 0.08	(2.8–3.1)	3.37	2.8 \pm 0.10	(2.7–3.0)	4.01	2.7	

Table 2.—Statistical comparison of selected cranial measurements of five adult male and four adult female *Rhinolophus arcuatus* meintyreii from the type locality. Statistics given are same as in Table 1. Measurements for holotype (CM 63497) are listed in right column of table. Significant differences between samples are indicated by a single asterisk for $P \leq 0.05$ and double asterisks for $P \leq 0.01$.

Measurements	Males			Females			Holotype
	Mean \pm 2 SE	(Range)	CV	Mean \pm 2 SE	(Range)	CV	
Greatest length of skull	23.0 \pm 0.20	(22.6–23.2)	0.95	22.2 \pm 0.31	(21.8–22.5)	1.39**	22.2
Condylbasal length	20.3 \pm 0.24	(20.0–20.7)	1.30	19.6 \pm 0.17	(19.4–19.8)	0.87**	19.4
Condyllocanine length	19.1 \pm 0.17	(18.9–19.4)	1.02	18.6 \pm 0.12	(18.5–18.7)	0.62**	18.7
Width of rostral swellings	5.7 \pm 0.06	(5.6–5.8)	1.24	5.5 \pm 0.08	(5.4–5.6)	1.48**	5.6
Least interorbital width	2.0 \pm 0.17	(1.7–2.1)	9.95	2.0 \pm 0.12	(1.9–2.1)	5.77	2.1
Zygomatic breadth	10.4 \pm 0.11	(10.3–10.6)	1.18	10.2 \pm 0.17	(10.0–10.4)	1.67	10.3
Breadth of braincase	9.2 \pm 0.17	(9.0–9.3)	1.41	8.9 \pm 0.10	(8.8–9.0)	1.07**	9.0
Mastoidal breadth	10.2 \pm 0.10	(10.0–10.3)	1.12	10.0 \pm 0.17	(9.8–10.2)	1.70	10.0
Alveolar breadth of canines	5.6 \pm 0.14	(5.4–5.8)	2.73	5.5 \pm 0.13	(5.4–5.7)	2.28	5.7
Crown breadth of third molars	7.9 \pm 0.12	(7.7–8.0)	1.69	8.0 \pm 0.13	(7.8–8.1)	1.62	8.0
Crown length of maxillary toothrow	8.4 \pm 0.05	(8.4–8.5)	0.65	8.2 \pm 0.06	(8.1–8.2)	0.71**	8.1
Length of complete mandible, from condyles	14.4 \pm 0.12	(14.2–14.5)	0.93	13.9 \pm 0.10	(13.8–14.0)	0.69**	14.0
Length of right ramus, from condyles	14.8 \pm 0.17	(14.6–15.0)	1.26	14.5 \pm 0.17	(14.3–14.6)	1.20*	14.3
Crown length of mandibular toothrow	8.8 \pm 0.13	(8.6–8.9)	1.61	8.5 \pm 0.13	(8.4–8.7)	1.48*	8.5

nine of the 14 cranial measurements tested. Generally, males have a longer skull, broader braincase, longer maxillary toothrow, more inflated nasal swellings, and larger, longer mandibles and mandibular toothrow. There were no significant differences between the samples for the external measurements that were tested. Except for total length, tail length, and weight, sample variances were equal.

Individual variation, as expressed by coefficients of variation, were generally low for both external and cranial measurements. Of the cranial measurements, least interorbital width was the only measurement with a value greater than 3. For the external measurements, 24 of the possible 38 coefficients of variation were less than 4. Exclusive of weight, only two measurements for females, length of tail and width of sella at base, had CVs greater than 6. Because males of *R. a. mcintyre* seem larger than females in most cranial measurements, future taxonomic studies of this species should allow for such secondary sexual variation in cranial measurements.

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